GRANULAR AGGREGATE RESOURCES,

HAMPSTEAD (NTS 21 G/9) MAP AREA, NEW BRUNSWICK

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HAMPSTEAD (NTS 21 G/9) MAP AREA, NEW BRUNSWICK

Minerals and Energy Division

Department of Natural Resources and Energy

New Brunswick

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Plate 87-6. Granular Aggregate Resources of Hampstead, 21 G/9 ..... in pocket

ABSTRACT

The Hampstead map area, exclusive of C.F.B. Gagetown, contains a volume of granular aggregate material estimated to exceed 11.5 million m^3. Most of this material occurs in glaciofluvial outwash deltas and associated ice-contact stratified drift in the southeastern and southwestern corners of the map area. The quality of the material in the area varies from poor to good. Coarse aggregate is predominant.

RÉSUMÉ

La région cartographique de Hampstead, à l'exception du territoire occupé par la Base des Forces armées de Gagetown, recèle un volume d'agrégats granulaires estimé à plus de 11,5 millions de mètres cubes. La plus grande partie de ces agrégats se trouve dans les deltas fluvioglaciaires et dans les moraines fluvioglaciaires laissées par le passage des glaciers dans les coins sud-est et sud-ouest de la région cartographique. La qualité de ces agrégats va de médiocre à bonne. Il s'agit en majeure partie d'agrégats à gros grains.

INTRODUCTION

LOCATION AND ACCESS

The Hampstead (21 G/9) map area is located in southwestern New Brunswick, along the Saint John River approximately midway between Fredericton and Saint John (Figure 1). It comprises a total area of 1080 km^2, lying between longitudes 66°00'W and 66°30'W, and latitudes 45°30'N and 45°45'N. C.F.B. Gagetown, which occupies approximately two-thirds of this area (Figure 2), was excluded from the study.

Access within the study area is via a number of Provincial highways, plus a network of local roads. Access to most of the significant granular aggregate deposits in this area is good.

PREVIOUS WORK IN THE AREA

Aspects of the surficial geology of the study area were described by Mathew (1879) and Chalmers (1885, 1890) in their early works on the surficial geology of southern New Brunswick. The surficial geology of the area has since been mapped at the regional scale (1:250 000) by Gadd (1973). The soils of the area, with associated information on surficial geology, were described by Aalund and Wicklund (1950) and Wicklund and Langmaid (1953). The results of the above studies have been compiled and summarized by Rampton et al. (1984).

Information on some of the aggregate extraction sites in the study area was provided by Hamilton and Carroll (1975) in their preliminary survey of the sand and gravel resources of

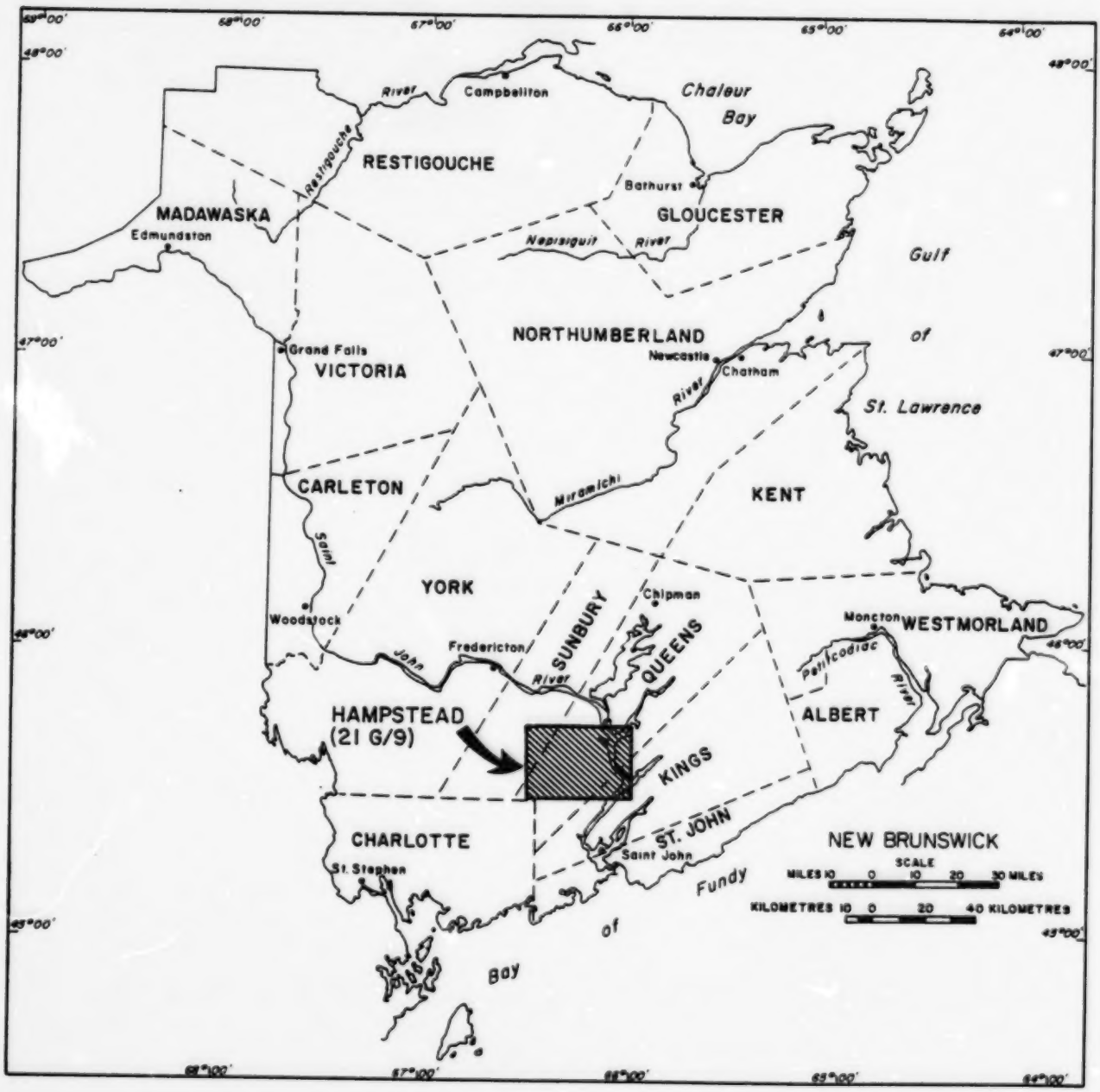


FIGURE 1. Location of the Hampstead map area.

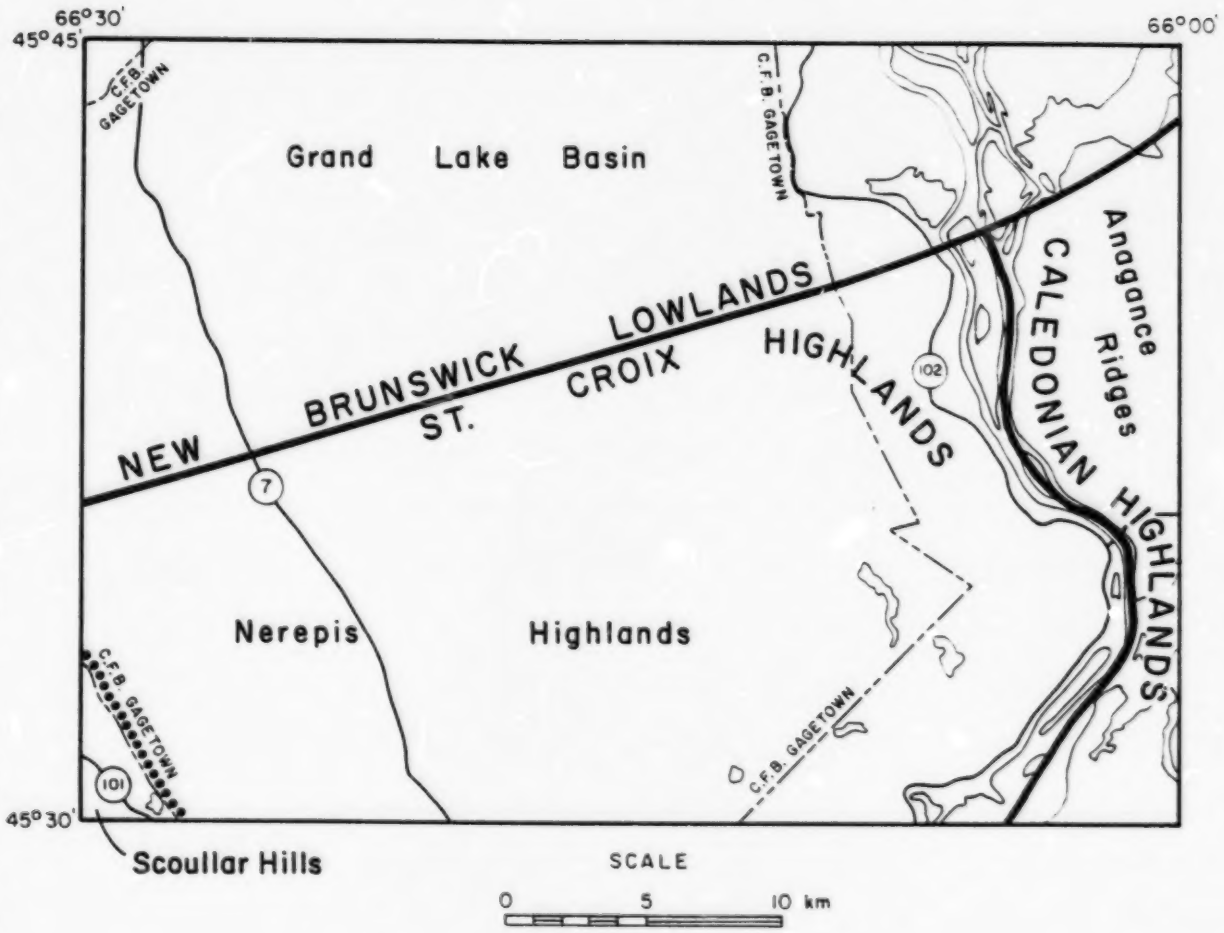


FIGURE 2. Physiographic units of the Hampstead map area (from Rampton et al. 1984).

the province. Brinsmead and Finamore (1977) mapped, in considerable detail, the granular aggregate resources of the southern half of the part of the map area to the east of the Saint John River.

THE PRESENT STUDY

The objective of this study is to provide basic information pertaining to the location, extent, thickness, and quality characteristics of the granular aggregate deposits in the Hampstead map area, exclusive of C.F.B. Gagetown. It is part of a province-wide inventory of granular aggregate resources.

Field work was carried out during two weeks in the summer of 1986. All drivable roads outside of C.F.B. Gagetown were surveyed, and all known accessible aggregate excavations were examined and described. Samples for textural and lithologic analysis were obtained from representative sites.

The granular aggregate deposits and site locations are plotted on the accompanying map (Plate 87-6). Detailed descriptions of the sampled sites are contained in the Appendix. These descriptions are accompanied by the sample analyses for these locations, available test data from the New Brunswick Department of Transportation (DOT), general comments pertaining to the deposits as a whole, and estimates of the workable reserves. Supplementary observations pertaining to other sites of interest follow the detailed descriptions.

ACKNOWLEDGEMENTS

Capable field assistance was provided by Christina L. McLellan, who also performed the pebble lithology analyses. The samples for textural analysis w re processed by ADI Limited of Fredericton. The report was typed by Diane Blair. The figures were drafted by Gerry Johnson, and the map by Vanderklift Exploration Services. The report, map, and figures were edited by Shasta A. Abbott.

PHYSIOGRAPHY AND GEOLOGY

PHYSIOGRAPHY

Physiographic Units: The Hampstead map area includes parts of three major physiographic units: the New Brunswick Lowlands in the northern part of the area; and the St. Croix Highlands, and Caledonian Highlands in the southern part of the area, to the west and east, respectively, of the Saint John River (Figure 2). The brief summaries that follow concerning these units and their subdivisions are based on the detailed comments of Rampton et al. (1984).

Within the study area, the Grand Lake Basin subunit of the New Brunswick Lowlands comprises an area of low rolling hills. In general, the surface slopes gently toward Grand Lake or the Oromocto River valley. Relief is generally less than 45 m, although the Saint John River is locally incised up to 90 m into the surface.

The northern part of the Nerepis Highlands subunit of the St. Croix Highlands comprises an area of undulating topography, where the ridges and hills stand 45 to 75 m above the levels of the adjacent valleys. In the southern part of the study area, relief in this subunit is high, in the order of 75 to 120 m, due to the presence of several structurally-controlled cuesta ridges. The portion of the Scoullar Hills subunit within the map area is a northeastward-sloping surface with a relief of about 30 m.

The Anagance Ridges subunit of the Caledonian Highlands is an area of valley and ridge topography. As a consequence, relief in this part of the map area is also high; generally 60 to 120 m.

Drainage: All of the Hampstead map area lies within the Saint John River drainage basin. Most of the individual streams exhibit a dendritic drainage pattern, locally deranged by glacial action. However, due to the arcuate shape of the Saint John River in the region, the area, as a whole, exhibits a radial pattern (Figure 3). The extreme western part of the area drains westward into the Oromocto River, and thence to the Saint John. The extreme north-central part of the area drains northward into the Saint John River, while the south-central part drains to the south, via the Nerepis River. In between, a number of streams drain eastward to southeastward into the Saint John River. For that part of the map area to the east of the Saint John River, the streams generally flow westward to southwestward.

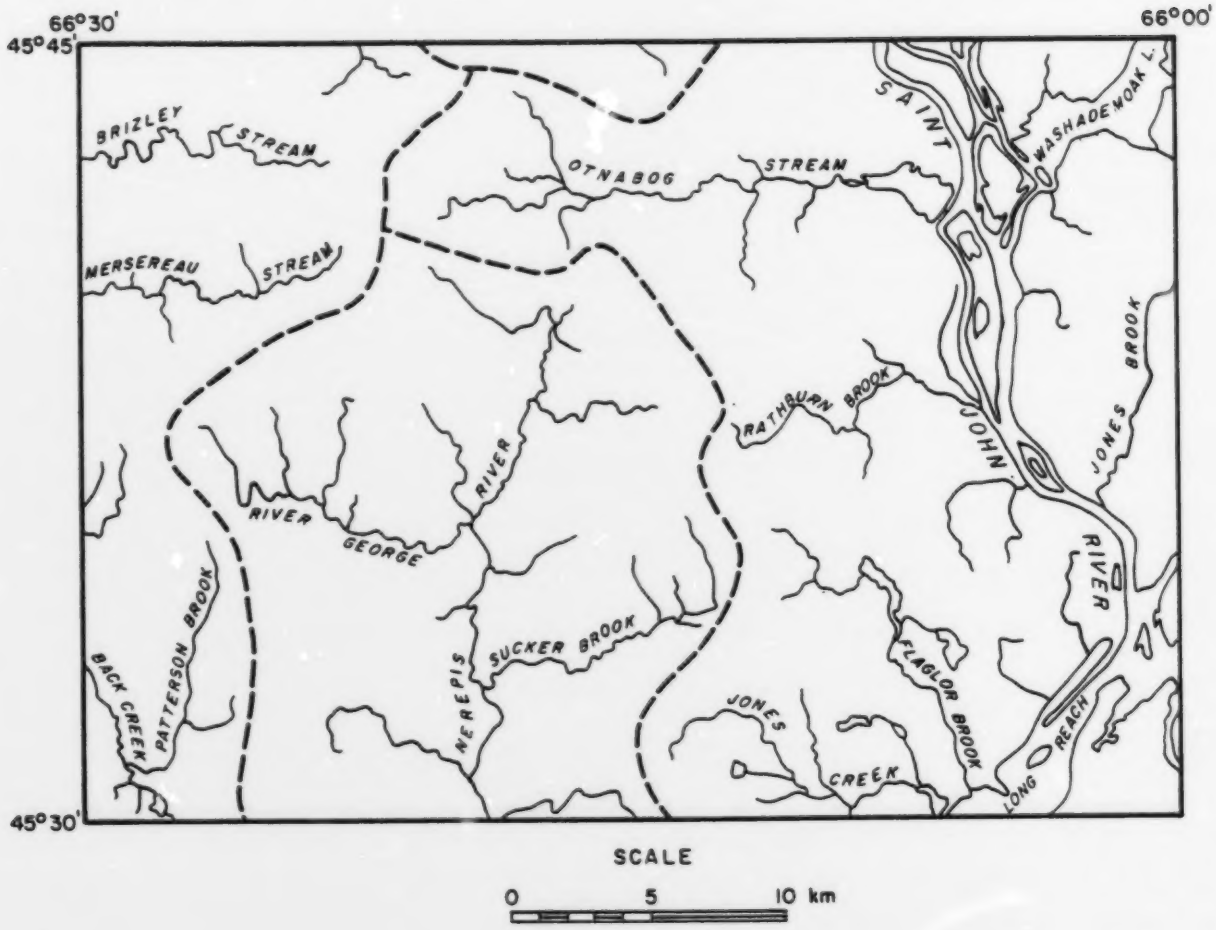


FIGURE 3. Major drainage elements of the Hampstead map area.

Due to its moderately high relief, most of the map area is moderately well to well drained (Rampton et al. 1984). However, a number of small lakes and boggy areas are found in bedrock basins or glacially dammed valleys. Extensive, marshy intervals are found locally along the Saint John River, due to slow aggradation of sediment caused by the rising of the marine base level in the Bay of Fundy.

BEDROCK GEOLOGY

The Hampstead map area is underlain by a diverse assemblage of rock types, ranging from Precambrian through to Pennsylvanian in age (MacKenzie 1964; Potter 1968). Clastic sedimentary rocks are predominant. The northern half of the map area is underlain primarily by Mississippian and Pennsylvanian sandstones, conglomerates, siltstones, and shales, with associated felsic and mafic volcanic units and a few areas of limestone (Figure 4). The southern half of the area is underlain primarily by fine-grained sedimentary rocks and their metamorphic equivalents. This part of the area also includes extensive areas of felsic and mafic volcanics, and several granite intrusions. The granite intrusion adjacent to the Saint John River (the Spoon Island granite) has been extensively quarried for building stone for more than 100 years (Parks 1914; New Brunswick Department of Natural Resources 1978).

The distribution of the major rock types in the Hampstead map area is outlined in Figure 4. Further details concerning the bedrock geology of the area can be obtained from MacKenzie (1964), and from more detailed maps listed in Carroll (1985).

SURFICIAL GEOLOGY

The surface topography of the Hampstead map area is predominantly bedrock controlled. Throughout almost all of the area, bedrock lies at the surface, or beneath a thin cover of till that is generally less than 1 m thick (Gadd 1973). The exceptions are in the Saint John River valley, where some extensive alluvial deposits are found, and in some of its tributary valleys, where glaciofluvial outwash deltas and associated ice-contact deposits may attain significant thicknesses. The distribution of these glaciofluvial deposits is outlined on the accompanying map (Plate 87-6). Further details concerning the surficial geology of the region can be obtained from Gadd (1973) and Rampton et al. (1984).

GRANULAR AGGREGATE RESOURCES

QUALITY

Analysis: The quality of an aggregate material is dependent upon two primary physical characteristics:

1) the grain-size characteristics of the material, and

2) the lithologies of its component clasts.

Grain-size Characteristics: The grain-size characteristics of an aggregate are determined by passing a sample of the material through a nest of sieves (A.S.T.M. C136-76) and they apply specifically to the sample examined. Therefore, an attempt was made when collecting the samples to obtain ones

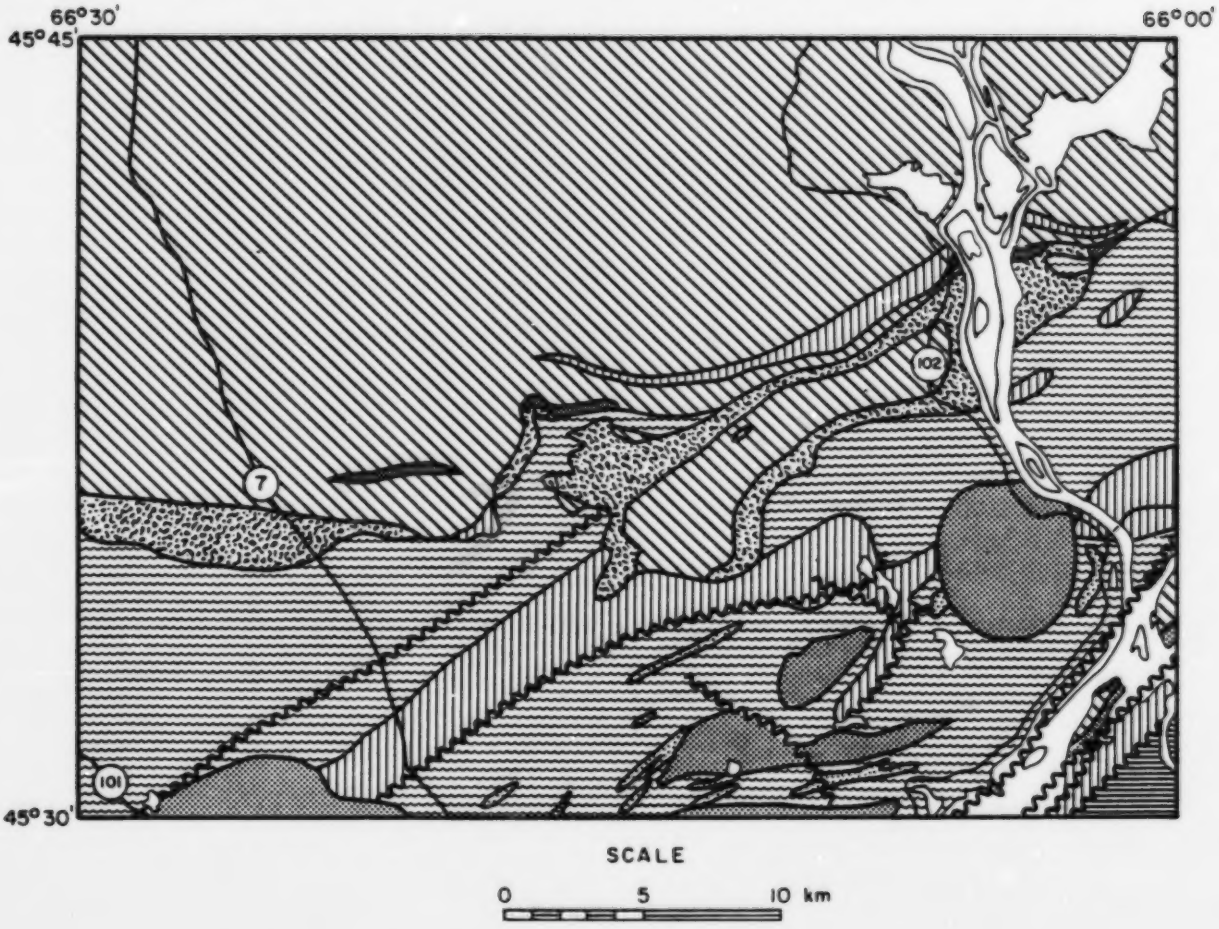
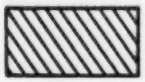


FIGURE 4. Bedrock geology of the Hampstead map area (derived from Potter 1968; MacKenzie 1964).

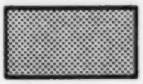
representative of the material in the observed sections. Samples weighing approximately 5 to 50 kg were obtained, the size of the sample being determined by the percentage of gravel in the material and its coarseness. Analysis of the samples was carried out using wet sieve analysis (A.S.T.M. C117-76) to

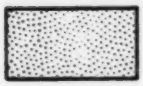
LEGEND


clastic sedimentary rocks
- sandstone, conglomerate, shale, siltstone; minor coal

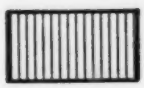
limestone

clastic sedimentary and metasedimentary rocks
-slate, argillite, hornfels, quartzite, shale, sandstone


felsic intrusive rocks
-granite, syenite, felsite, granophyre; includes granitic gneiss

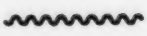

mafic intrusive rocks
-gabbro, diabase

felsic extrusive rocks
-rhyolite flows, breccias, and tuffs


mafic extrusive rocks
-basaltic flows, breccias, and tuffs; minor andesitic rocks

metavolcanic rocks
-mafic to felsic metavolcanics

SYMBOLS


fault

accurately determine the fines (silt and clay) content. The results of these mechanical analyses are tabulated in the Appendix.

The grain-size characteristics of the material were also estimated in the field, on a qualitative basis, using the standard geological grain-size classification outlined in Table I. The relative proportions of the major grain-size classes within the materials are described in terms of the textural classification outlined in Table II. In addition, the terms "fine aggregate" and "coarse aggregate" are used to identify material predominantly finer and predominantly coarser, respectively, than 4.75 mm (A.S.T.M. C125-76).

Lithologic Characteristics: The composition of the clasts within an aggregate deposit has a significant effect on the quality of the material. Preferably, clasts should exhibit three primary characteristics: a) they should be of good physical quality, b) they should be uncoated, and c) they should not react with any cementing materials.

To determine the lithologic characteristics of a deposit, a sample of approximately 100 pebbles in the 25 to 50 mm size range was collected from a fresh exposure. The lithologies represented by the clasts were determined, and they were divided into two groups, sound and unsound. The two groups are differentiated primarily on the basis of the resistance of the clasts to disintegration under mechanical impact (with the exception of chert, which is classed as unsound due to its known chemical instability in concrete). The results of this

TABLE I

GRAIN-SIZE CLASSIFICATION
(Classification modified after Friedman and Sanders 1978)

Descriptive Size Category	Limiting Size (Minimum)	Approximate Equivalent In DOT Sieve Sizes (Not Passing)
Boulders	256 mm	-
Cobbles		
- large	128 mm	-
- small	64 mm	75 mm
Gravel		
- very coarse	32 mm	31.5 mm
- coarse	16 mm	19.0 mm
- medium	8 mm	9.5 mm
- fine	4 mm	4.75 mm
- very fine	2 mm	2.36 mm
Sand		
- very coarse	1 mm	1.18 mm
- coarse	500 um	600 um
- medium	250 um	300 um
- fine	125 um	150 um
- very fine	63 um	75 um
Silt and Clay (fines)	-	-

TABLE II

TEXTURAL CLASSIFICATION
(Modified from Folk 1968)

	% Passing 2.35 mm (Approximate Range)
Gravel	0 - 20
Sandy Gravel	20 - 70
Gravelly Sand	70 - 95
Sand	95 - 100

	% Passing 75 um (Approximate)
Silty	10+
Slightly Silty	5 - 10

test should not be confused with those from quantitative soundness tests (e.g., the sodium or magnesium sulphate tests), or those from abrasion tests (e.g., the Los Angeles abrasion loss test).

The results of the above qualitative soundness tests, plus any quantitative test results available from DOT, are tabulated in the Appendix.

Limitations: There are five major factors that serve to degrade the quality of an aggregate: two relate to texture, and three to clast lithology. These are: 1) an excessive fine particle content; 2) poor grading; 3) poor physical quality of clasts; 4) coatings on clasts; and 5) reactive character of clasts (i.e., alkali-reactivity in cement).

Fine Particle Content: A content of fine particulate matter (that material passing through a 75 um sieve) in excess of 5% in an aggregate is generally considered deleterious. For some usages, even lower percentages are specified (Bates 1969).

Fine particles may occur as discrete beds within a deposit, as coatings on larger clasts, as disseminated particles throughout a deposit, or as some combination of the above. If an aggregate contains fines in excess of the specified limits for a particular use, it may be upgraded to an acceptable level by washing, with an attendant significant increase in the cost of exploitation. However, in the first case above, this may be avoided by selective extraction of material.

Grading: Grading refers to the particle size distribution within the aggregate (i.e., the relative proportions of material in the different size categories). The natural grading of a deposit may be improved by crushing, by selective screening and recombination, or by the combination of materials from different sources or areas. However, such processing increases production costs. Excessive variability in the grading of a deposit can also lead to production problems.

Grading limits are specified by users (e.g., DOT), and will vary, depending upon the proposed use of the material. Poor grading may restrict the potential of certain deposits for certain uses.

Physical Quality: Ideally, clasts should be hard, strong, and durable. Soft materials such as shale, schist, and friable sandstones are unsuitable for use in most aggregates, since they disintegrate easily, while porous or fractured rock fragments may split due to the expansion of water as it freezes (Bates 1969). Poor physical quality is often the most significant quality-limiting factor in New Brunswick aggregates.

Clast Coatings: The presence of silt, clay, carbonate, or oxide coatings on clasts renders them unsuitable for use in high-specification aggregate, since they weaken the bond between the clast and the cementing agent, and in concrete may become chemically unstable (Bates 1969). Silt and clay coatings may be removed by washing, with a consequent increase in the cost of exploitation. Coatings of this type are prevalent on clasts in deposits with high fine particle contents, but may also be found in other deposits.

Alkali-reactivity: Clasts that contain opaline or cryptocrystalline silica react with the alkalies in cement. As a result of this reaction, the clasts expand, producing cracks within the concrete that make it susceptible to freeze-thaw and other destructive processes. The primary offenders have been considered to be chert and some felsic extrusive rocks (Bates 1969). However, other rocks, such as schists, quartzites, greywackes, argillites, and phyllites have been shown to cause problems (Swenson 1973). In cases of suspected reactivity, the use of low-alkali portland cement or partial substitution of a pozzolanic material - such as fly-ash or finely ground siliceous material - for some of the cement is recommended (Bates 1969; Swenson 1973).

In the Hampstead map area, the granular aggregate deposits have a significant content of potentially reactive clasts. Consequently, the materials from these deposits should be assumed to be reactive, until proven otherwise.

DESCRIPTION OF MAP UNITS

The major granular aggregate resources of the study area are found in deposits of three basic types. These are: 1) ice-contact stratified drift; 2) glaciofluvial outwash and outwash deltas; and 3) ancient alluvium. A general description of each of these deposit types is given below.

Ice-contact Stratified Drift: Ice-contact stratified drift deposits are those deposits of glaciofluvial origin that are formed of sediment deposited by meltwater on or against

glacial ice. Characteristically, such deposits form distinctive constructional landforms of various types. Within the study area, these include eskers, kame terraces, plus a few features of indeterminate, but presumed ice-contact, origin.

Eskers are linear accumulations of sediment formed either by deposition from meltwater streams flowing in tunnels within a melting glacier (Flint 1971), or by deposition of a series of overlapping fans or "beads" at the point of stream discharge from a retreating glacier (Embleton and King 1975). Both types of eskers are present in the study area. Kame terraces consist of linear accumulations of sediment deposited by meltwater between an ice margin and a valley wall (Sugden and John 1976).

In general, ice-contact stratified drift deposits consist primarily of sand or gravel, with variable quantities of fines, cobbles and boulders. The sorting can vary from very poor to good, while the texture commonly exhibits abrupt lateral and vertical variations - sometimes due to postdepositional deformation as a result of slumping subsequent to the withdrawal of the supporting glacier ice. Because of their close association with the glacier, such deposits may contain pockets of ablation or lodgement till.

Glaciofluvial Outwash: Glaciofluvial outwash comprises the sediment that is deposited beyond the margins of a glacier by the action of meltwater streams. In general, this material consists of well-washed, horizontally stratified sand or gravel. These deposits usually exhibit a flat, gently sloping topography. However, the meltwater streams that form these deposits

may transport and deposit blocks of ice in addition to their sediment load. The melting-out of buried ice blocks within the outwash deposits results in the formation of small circular to irregular depressions in their surfaces referred to as kettle holes (Flint 1971).

Where meltwater streams discharge into bodies of standing water, outwash deltas are formed. These deposits consist of a topset unit of glaciofluvial outwash, typically one to several metres thick, overlying steeply dipping foreset beds, which in turn overlie flat-lying bottomset beds. The foreset beds are typically finer grained than the topset beds, and often consist primarily of fine aggregate, sometimes silty. The bottomset beds generally consist of silt and clay, and thus do not constitute an aggregate resource.

Ancient Alluvium: Alluvium consists of unconsolidated material that was deposited by the flowing water of streams or rivers during the postglacial period. Ancient alluvium is that alluvial material that is found in terraces that now lie above the level of the modern floodplain. Characteristically, the material consists of horizontally stratified sand or gravel, although it may also contain a significant silt component (usually in the form of discrete beds, commonly at the surface of the deposit). Within the study area, the potential of such deposits to serve as aggregate sources is limited by their shallow water tables.

MAJOR GRANULAR AGGREGATE SOURCES

The largest concentration of granular aggregate material in the study area is found along Flaglor Brook in the southeastern corner of the map area. The Flaglor outwash delta (G9-7, 104) and its feeder esker (G9-4) contain workable reserves of poor- to good-quality aggregate estimated to exceed 4.5 million m^3. Most of this material appears to be coarse aggregate.

The other major occurrences in the study area are the Wirral outwash delta, in the southwestern corner of the map area (G9-1), and the Beulah outwash delta at the east-central margin of the area (G9-11, 12, 106). Both deposits contain an estimated 2 million m^3 each of workable material. The Wirral delta contains predominantly poor- to good-quality coarse aggregate. In contrast, the Beulah delta contains a significant amount of fine aggregate. In addition, its coarse aggregate component appears to be of generally poorer quality.

Significant volumes of material are also present in the ice-contact/outwash complex along Jones Creek (G9-5, 6; 1 million m^3), in the ice-contact deposits along Jones Brook (G9-10, 105; 600 000 m^3), and in the esker near the mouth of Jones Brook (G9-13; 700 000 m^3). The remaining deposits in the study area are either small in size, or contain relatively small volumes of workable material. However, they may constitute valuable local sources of aggregate materials.

For further details concerning these deposits, please refer to the descriptions in the Appendix.

CONCLUSIONS

The workable reserves of granular aggregate material in the Hampstead map area, exclusive of C.F.B. Gagetown, are estimated to be in excess of 11.5 million m^3. This material is concentrated in three areas. Apprxomately half lies to the west of the Saint John River in the southeastern corner of the area; about one-quarter is concentrated near the east-central margin of the area; and most of the remainder is found in the southwestern corner of the area.

The quality of the material in the area varies from poor to good. In general, the better quality material is found in the southern part of the area, where, fortuitously, most of the significant deposits are located.

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APPENDIX A

SITE DESCRIPTIONS

HAMPSTEAD MAP AREA

21 G/9

LOCATION:	G9-1	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash (delta)	**COUNTY:**	Queens
EXPOSURE TYPE:	Pit	**PARISH:**	Petersville
STATUS:	Active-on-demand	**UTM:**	972 421

SECTION DESCRIPTION & COMMENTS:

0.6 m Soil: Slightly silty soil, developed on the underlying material.

1.2 m Cobbly Sandy Gravel: Crudely stratified, cobbly medium to very coarse gravel and coarse to very coarse sand, with a few boulders; clasts are subangular to rounded, with moderate to heavy silt coatings; maximum clast size is 1.5 m; clasts greater than 0.1 m in size are estimated to comprise 5 to 10% of the material.

5.8 m Slump Covered: Assumed to be material as above.

The material in the two pits to the west (UTM'S 966 422 and 969 421) is similar to that described above, but slightly finer overall, with some sand beds and less oversize material. Both of these pits are about 11.5 m deep. The latter pit exposes northward-dipping foreset-type beds. The small pit to the south, along Three Bridge Brook, exposes similar material.

The G9-1 area has been intensively tested by DOT (1959, 1974). Their test results were as follows:

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	68.8	51.0	47.1	38.6	32.9	27.4	19.1	8.5	3.8	2.8	2.5

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 41%	Sound Lithotypes 59%
sandstone 7; felsic intrusive 5; shale 5; schist 5; chert 4; slate 4; weathered 4; mafic extrusive 2; conglomerate 2; felsic extrusive 1; siltstone 1; metasedimentary 1	quartzite 11; sandstone 9; argillite 7; gneiss 6; greywacke 5; mafic extrusive 4; felsic extrusive 3; siltstone 3; metasedimentary 3; quartz 3; felsic intrusive 1; mafic intrusive 1; limestone 1; metavolcanic 1; hornfels 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
100	40	5	2 million

LOCATION #: G9-1 (cont'd)

Pit Run Material (34 samples)

Mechanical Analysis
55 to 100% passing 50 mm (average 79%)
16 to 69% passing 4.75 mm (average 35%)
0.1 to 6.3% passing 75 um (average 1.9%)

Los Angeles Abrasion Loss: 24.6 to 28.2% (average 25.9%)

Crushed Material (1 sample)

Mechanical Analysis
48% passing 4.75 mm; 3.9% passing 75 um

Soundness Loss: stone 4.31%; sand 3.64%

DOT (1974) recommended most of the material as suitable for use as borrow, subbase, base-course, cover, and asphaltic concrete aggregate. However, about 25% of the samples were of poorer quality; most of these were suitable for up to base-course usage, but one sample was suitable only for use as borrow.

This deposit is interpreted as an outwash delta formed by meltwater streams flowing northeastward into a standing body of water in Back Creek valley (Gadd 1973). The configuration of the southern portion of the deposit, and the coarseness of the material at site G9-1, as compared to the pits to the west, suggests that the delta may have formed against an ice mass occupying the Back Creek valley from Wirral Lake southward. Consequently, the waters ponded in the valley may have been glaciolacustrine, rather than glaciomarine.

LOCATION:	G9-2	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact	**COUNTY:**	Queens
EXPOSURE TYPE:	Pit	**PARISH:**	Hampstead
STATUS:	Active-on-demand	**UTM:**	198 651

SECTION DESCRIPTION & COMMENTS:

North Face, Western End

0.6 m Soil: Developed on the underlying till.

0.8 m Till: Dense, reddish brown, silty sandy till; contains a large number of cobbles and boulders; maximum clast size is 1.5 m.

0.9 m Sandy Silt: Dense, reddish brown, sandy silt, with thin interbeds of sand or gravelly sand.

0.4 m Gravelly Sand: Fine to coarse sand and fine to medium gravel.

20.6 m Slump Covered: Assumed to be mainly sand and gravel; may contain some till units; partly overgrown with vegetation.

1.9 m Cobbly Sandy Gravel: Very poorly sorted, cobbly medium to very coarse gravel and fine to very coarse sand; contains minor lenses of openwork gravel or fine to coarse sand, and some till-like layers; crudely stratified; sample A was obtained from this unit.

2.3 m Slump Covered: Assumed to be material as above.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	100mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass. A	89.4	64.3	58.3	45.6	38.6	31.8	25.8	19.1	11.3	6.2	3.9
B	100.0	90.5	87.2	76.8	66.2	56.8	46.9	36.2	22.9	10.9	3.4

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 37%	Sound Lithotypes 63%
sandstone 9; felsic intrusive 5; mafic extrusive 4; chert 4; shale 4; slate 3; felsic extrusive 2; mafic intrusive 2; conglomerate 1; siltstone 1; schist 1; weathered 1	quartzite 14; quartz 13; felsic intrusive 7; felsic extrusive 6; sandstone 5; mafic extrusive 4; mafic intrusive 3; metasedimentary 3; gneiss 3; argillite 2; greywacke 1; limestone 1; metavolcanic 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
7	6	5	300 000

LOCATION #: G9-2 (cont'd)

West Face (40 m west of the above section)

Surface material has been removed.

1.5 m Silty Sandy Gravel: Dense, silty very fine to fine gravel and very fine to coarse sand.

0.5 to 2.0 m Gravel: A trough-fill unit of gravel beds of variable texture; the beds vary from very fine to medium gravel through to cobbly and bouldery coarse to very coarse gravel; approximately half of the units are openwork; the remainder have a matrix of very silty very fine to coarse sand in the upper part of the unit, and of clean very fine to fine sand in the lower part of the unit.

1.0 to 2.5 m Sand and Gravel: Horizontally bedded, syndepositionally faulted (faults do not extend into the overlying unit) sand and sandy gravel beds; the beds are 5 to 50 cm thick; the sand beds vary in texture from very fine to fine sand with minor silty bands through to clean medium to coarse sand; the gravel beds are predominantly very fine to coarse gravel and medium to very coarse sand; clasts are subangular to rounded, with very light silt coatings; sample B was obtained from this unit.

1.4 m Slump Covered: Assumed to be material as above.

This pit has been sampled by DOT (1974). Their test results were as follows:

Mechanical Analysis (4 samples)
80 to 94% passing 50 mm (average 88%)
13 to 37% passing 4.75 mm (average 25%)
2.2 to 6.8% passing 75 um (average 4.8%)

Los Angeles Abrasion Loss: 25.1 to 25.9% (average 25.5%)

Recommended for use as borrow, subbase, and base-course aggregate.

This deposit appears to be a segment of a kame terrace. An area of apparently similar material is present to the east of the above segment. An old, abandoned pit (UTM 207 650) in this eastern area is about 9 m deep. The material exposed is a finer sandy gravel than that at G9-2; fine to medium gravel and predominantly medium sand. The character of the material in the remainder of this area is unknown.

The G9-2 area appears to be nearing depletion. The reserve estimate pertains to the eastern deposit area.

LOCATION:	G9-3	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash/ice-contact	**COUNTY:**	Queens
EXPOSURE TYPE:	Pit	**PARISH:**	Hampstead
STATUS:	Inactive	**UTM:**	240 572

SECTION DESCRIPTION & COMMENTS:

0.5 m Soil: Silty soil, developed on the underlying material; locally removed.

1.9 m Sandy Gravel: Cross-bedded (east-southeastward-dipping) fine to very coarse gravel and fine to very coarse sand; clasts are subangular to rounded, with moderate to heavy silt coatings.

1.7 m Slump Covered: Assumed to be material as above.

This pit has been developed at the contact between the outwash and the ice-contact deposit (probably a kame terrace). The section described above is in the lower lift, in the outwash deposit at the southeast end of the pit. The upper lift, in the ice-contact deposit, is abandoned and largely overgrown; however, it appears to contain generally similar material. Maximum clast size in the pit area is 0.7 m, but clasts greater than 0.1 m in size are very rare. Pockets of gravelly sand are present in both lifts. The pit face in the upper lift is up to 19 m high.

This pit has been sampled by DOT (1978). From their sketch, it appears that they obtained two samples from the outwash (one for crushing) and five from the ice-contact material. The results of their tests are as follows:

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	94.3	76.6	67.7	49.3	35.7	26.2	20.6	16.0	9.8	4.8	3.0

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 35%	Sound Lithotypes 65%
sandstone 8; mafic extrusive 7; conglomerate 6; weathered 4; felsic intrusive 3; chert 3; mafic intrusive 2; shale 1; slate 1	quartzite 27; quartz 9; mafic extrusive 6; felsic intrusive 4; felsic extrusive 4; sandstone 4; mafic intrusive 3; greywacke 3; argillite 2; conglomerate 1; siltstone 1; metasedimentary 1

ESTIMATION OF RESERVES:

	Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
A	5	4	5	200 000
B	13	5	2	100 000

LOCATION #: G9-3 (cont'd)

Pit Run Material (6 samples)

Mechanical Analysis: (?)outwash (1 sample)
95% passing 50 mm; 46% passing 4.75 mm; 4.6% passing 75 um

(?)ice-contact (5 samples)
83 to 94% passing 50 mm (average 91%)
55 to 61% passing 4.75 mm (average 59%)
11.7 to 15.9% passing 75 um (average 14.7%)

Los Angeles Abrasion Loss: 29.0 to 29.2%

Recommended for use as borrow only.

Crushed Material (1 sample)

Mechanical Analysis
45% passing 4.75 mm; 4.4% passing 75 um

Absorption: stone 1.84%; sand 1.79%
Soundness Loss: stone 28.34%; sand 13.50%
Sand Equivalent 44

Recommended for use as borrow and subbase aggregate.

Reserve estimates for the two deposit types are calculated separately: A) for the ice-contact material, and B) for the outwash. The area of the latter deposit is unknown; consequently, reserves could be greater than estimated.

LOCATION:	G9-4	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact (esker)	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Greenwich
STATUS:	Abandoned	**UTM:**	241 477

SECTION DESCRIPTION & COMMENTS:

0.6 m Soil: Slightly silty soil, developed on the underlying material.

1.2 m Sandy Gravel: Subhorizontally stratified very fine to coarse gravel and coarse to very coarse sand, with a few cobbles; clasts are angular to rounded, with light to moderate silt coatings; maximum clast size is 0.3 m; clasts larger than 0.1 m in size comprise less than 1% of the material.

3.2 m Slump Covered: Assumed to be material as above; a small exposure of bedrock outcrop is present in the middle of the section at the west end of the pit.

This pit is in a segment of a small esker, that extends down Flaglor Brook to the Flaglor delta (see G9-7, 104). There are no other good exposures in this deposit. Consequently, the character of the material in the remainder of the deposit is unknown. It is assumed to be generally similar to that described above.

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	92.6	77.6	72.2	59.6	46.2	30.8	13.9	4.3	2.5	1.9	1.6

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 48%	Sound Lithotypes 52%
shale 7; slate 7; weathered 7; felsic intrusive 5; mafic extrusive 5; sandstone 5; chert 4; mafic intrusive 3; siltstone 2; felsic extrusive 1; conglomerate 1; schist 1	quartzite 19; argillite 7; mafic extrusive 6; greywacke 6; felsic extrusive 4; quartz 3; sandstone 2; limestone 2; felsic intrusive 1; mafic intrusive 1; metavolcanic 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
10	10	2	200 000

LOCATION:	G9-5	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact (esker)	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Greenwich
STATUS:	Active	**UTM:**	212 429

SECTION DESCRIPTION & COMMENTS:

0.6 m Soil: Slightly silty soil, developed on the underlying material.

1.7 m Cobble Gravel: Massive, coarse to very coarse gravel and cobbles; sample A was obtained from this unit.

2.8 m Sandy Gravel: Cross-bedded fine to very coarse gravel and medium to very coarse sand, with a few beds (up to 0.3 m in thickness) of gravelly medium to very coarse sand, and openwork very fine to coarse gravel; the beds appear to be large-scale, eastward-dipping, trough beds; sample B was obtained from this unit.

2.8 m Slump Covered: Assumed to be material as above.

The above section is in the flank of a large esker segment. Maximum section height is 20.7 m. The deposit appears to consist of alternating thick units of material similar to samples A and B. Maximum clast size in the pit area is 0.5 m. An estimated 5% of the material consists of clasts exceeding 0.1 m in size. Clasts are subangular to subrounded, with heavy silt coatings. Reserve estimate A pertains to this segment of the esker.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass. A	41.2	25.8	22.7	19.2	16.3	13.8	9.5	5.4	3.2	2.3	1.9
B	92.8	79.7	74.7	63.4	50.2	34.3	20.0	9.8	5.2	3.8	3.1

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 53%	Sound Lithotypes 47%
schist 19; weathered 10; slate 8; mafic extrusive 4; shale 3; felsic extrusive 2; sandstone 2; siltstone 2; chert 2; metasedimentary 1	argillite 9; quartzite 9; mafic extrusive 8; mafic intrusive 4; quartz 4; felsic extrusive 3; sandstone 2; limestone 2; hornfels 2; siltstone 1; greywacke 1; metavolcanic 1; metasedimentary 1

ESTIMATION OF RESERVES:

	Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
A	4	2	10	200 000
B	24	15	2	300 000

LOCATION #: G9-5 **(cont'd)**

Up to 2 m of cobbly sandy gravel, similar to that described above, is exposed in a road cut through the area of ice-contact material to the west. Test pitting would be required to accurately assess the aggregate potential of this area. Consequently, the reserve estimate for this area (B) is conservative.

Up to 1 m of sandy gravel is exposed in the ancient alluvial deposit at Lynch Corner. Workable reserves in this deposit are considered to be limited, due to a shallow water table and residential developments.

LOCATION:	G9-6	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash/ice-contact	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Greenwich
STATUS:	Inactive	**UTM:**	219 426

SECTION DESCRIPTION & COMMENTS:

0.4 m Soil: Developed on the underlying material; locally removed.

2.1 m Sand and Gravel: Subhorizontally stratified, interbedded sand, gravelly sand, and sandy gravel; both the sand and the gravel fractions are predominantly fine to coarse; clasts are subangular to rounded, with very light to light silt coatings.

0.9 m Slump Covered: Assumed to be material as above.

This pit has been developed at the contact between the outwash and ice-contact deposits. The apparent stratigraphy in the pit comprises an ice-contact ridge to the east, with up to 1.5 m of marine clay draped over its flank, that is in turn overlain by the outwash material. The above section is representative of the outwash deposit. The ice-contact material is not well exposed, but is presumed to be similar to, but finer than, that at G9-5. Maximum clast size in the pit area is 0.6 m; however, clasts larger than 0.1 m in size are very rare.

Estimated reserves are calculated in three parts: A) for the ice-contact ridge segment containing the above pit; B) for the smaller ice-contact ridge segment to the southeast; and C) for the flanking outwash material, within the limits of the map area.

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	100.0	87.0	79.6	69.7	61.9	55.7	48.1	33.4	13.9	3.7	1.2

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 43%	Sound Lithotypes 57%
schist 10; slate 10; shale 9; weathered 5; siltstone 3; chert 2; mafic intrusive 1; mafic extrusive 1; sandstone 1; metasedimentary 1	quartzite 19; argillite 8; felsic extrusive 4; mafic intrusive 4; hornfels 4; felsic intrusive 3; greywacke 3; mafic extrusive 2; sandstone 2; siltstone 2; limestone 2; quartz 2; metavolcanic 1; gneiss 1

ESTIMATION OF RESERVES:

	Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
A	8	5	5	250 000
B	3	3	5	150 000
C	14	5	2	100 000

LOCATION:	G9-7	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash (delta)	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Greenwich
STATUS:	Inactive	**UTM:**	270 440

SECTION DESCRIPTION & COMMENTS:

0.5 m Soil: Silty soil, developed on the underlying material.

2.7 m Sand and Gravel: Cross-bedded (possibly large-scale trough beds) sand and gravel; individual beds may be sandy gravel, gravelly sand, openwork gravel, or sand (minor); the sandy gravel and gravelly sand beds consist predominantly of coarse to very coarse sand and fine to very coarse gravel; the openwork gravels vary from fine to medium gravel through to medium to very coarse gravel with a few cobbles; the sand beds are predominantly medium to coarse sand; clasts are subangular to subrounded, with light to moderate silt coatings; maximum clast size is 0.4 m, but less than 1% of the material consists of clasts greater than 0.1 m in size.

2.9 m Slump Covered: Assumed to be sand and gravel; if the deposit is a delta, the material may be much finer than that above.

This pit area has been extensively sampled by DOT (1978). Their test data are summarized below:

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	91.9	67.4	59.6	42.2	29.8	20.9	12.5	6.0	2.6	1.2	0.8

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 40%	Sound Lithotypes 60%
slate 6; chert 5; schist 5; weathered 5; sandstone 4; felsic intrusive 3; mafic intrusive 3; shale 3; felsic extrusive 2; mafic extrusive 2; conglomerate 1; metavolcanic 1	quartzite 15; argillite 8; quartz 7; felsic extrusive 5; sandstone 5; metavolcanic 4; mafic intrusive 3; mafic extrusive 3; gneiss 3; siltstone 2; felsic intrusive 1; greywacke 1; limestone 1; metasedimentary 1; hornfels 1

ESTIMATION OF RESERVES:

	Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
A	30	12	4	480 000
B	33	17	2	340 000

LOCATION #: G9-7 (cont'd)

Pit Run Material (23 samples)

Mechanical Analysis
75 to 100% passing 50 mm (average 95%)
38 to 82% passing 4.75 mm (average 61%)
0.9 to 6.0% passing 75 um (average 2.6%)

Los Angeles Abrasion Loss: 20.0 to 24.2% (average 21.8%)

Recommended for use as borrow, with some of the coarse material also suitable for use as subbase or base-course material, and the fine material for winter sand.

Crushed Material (2 samples)

Mechanical Analysis
61 and 66% passing 4.75 mm
1.1 and 3.6% passing 75 um

Absorption: stone 2.10 and 2.30%; sand 1.71 and 2.02%
Soundness Loss: stone 3.18 and 3.57%; sand 1.80 and 2.15%
Sand Equivalent: 67 and 83

Recommended for use as asphaltic base and seal aggregate.

This site is in a low-level delta deposit at the mouth of Flaglor Brook. The deposit is presumed to be of glaciofluvial, rather than alluvial, origin because the sediment load currently carried by Flaglor Brook appears incompatible with the large volume of material in this deposit.

Reserve estimate A pertains to that portion of the deposit to the east of Flaglor Brook; B to the portion to the west. See G9-104 for the reserve estimate for the high-level delta deposit.

LOCATION:	G9-8	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Greenwich
STATUS:	Active-on-demand	**UTM:**	317 492

SECTION DESCRIPTION & COMMENTS:

0.5 m Soil: Slightly silty soil, developed on the underlying material.

2.7 m Gravelly Sand: Trough cross-bedded fine to very coarse sand, with minor gravel, varying from very fine to coarse; Sample A was obtained from this unit.

6.1 m Gravel: Cross-bedded (southward-dipping) fine to very coarse gravel, with minor medium to very coarse sand, and a few cobbles; Sample B was obtained from the upper 1.2 m of this unit.

1.4 m Slump Covered: Assumed to be material as above.

Clasts in this deposit are subangular to rounded, with very light to light silt coatings, and some calcite coatings. Many of the smaller clasts are platy. Maximum clast size in the pit area is 0.8 m; however, clasts exceeding 0.1 m in size are estimated to comprise less than 1% of the material.

This deposit has been tested by DOT (1978). Their test results are summarized below:

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass. A	100.0	97.8	96.7	94.1	91.8	87.2	75.2	48.6	19.3	6.4	2.9
B	94.0	68.3	57.7	36.5	22.3	12.7	7.0	3.7	1.9	1.0	0.5

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 33%	Sound Lithotypes 67%
shale 6; schist 6; sandstone 3; chert 3; metavolcanic 3; slate 3; felsic intrusive 2; mafic extrusive 2; weathered 2; mafic intrusive 1; conglomerate 1; siltstone 1	argillite 14; quartzite 11; sandstone 10; quartz 8; mafic extrusive 4; felsic intrusive 3; limestone 3; hornfels 3; felsic extrusive 2; siltstone 2; greywacke 2; metasedimentary 2; mafic intrusive 1; metavolcanic 1; gneiss 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
18	4	5	200 000

LOCATION #: G9-8 (cont'd)

Pit Run Material (8 samples)

Mechanical Analysis
50 to 78% passing 4.75 mm (average 58%)
1.4 to 9.3% passing 75 um (average 3.1%)

Los Angeles Abrasion Loss: 22.8 to 25.6% (average 24.2%)

Recommended for use as borrow and subbase aggregate.

Crushed Material (1 sample)

Mechanical Analysis
59% passing 4.75 mm; 3.6% passing 75 um

Absorption: stone 1.75%; sand 2.09%
Soundness Loss: stone 3.23%; sand 2.44%
Sand Equivalent: 84

Recommended for use as asphaltic seal aggregate.

The mode of origin of this deposit is unknown. It is presumed to be ice-contact stratified drift.

LOCATION:	G9-9	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash	**COUNTY:**	Queens
EXPOSURE TYPE:	Pit	**PARISH:**	Wickham
STATUS:	Abandoned	**UTM:**	292 588

SECTION DESCRIPTION & COMMENTS:

0.5 m Soil: Slightly silty soil, developed on the underlying material.

0.5 m Sandy Gravel: Cross-bedded (southward-dipping) fine to very coarse gravel and fine to coarse sand, with minor sand lenses.

0.9 m Gravelly Sand: Cross-bedded (southward-dipping) fine to very coarse sand and predominantly very fine to medium gravel; contains minor thin beds of fine to medium sand; the sample was obtained from this unit.

2.3 m Slump Covered: Assumed to be material as above.

Clasts in this deposit are subangular to rounded, with light to moderate silt coatings. Maximum clast size is 0.3 m, but clasts exceeding 0.1 m in size are estimated to comprise less than 1% of the material.

This deposit is too small to identify from material photographs. Similar small deposits, as yet undiscovered, may be present in other valleys in the study area.

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass.	100.0	96.7	96.0	86.8	76.5	67.5	55.9	37.8	19.1	5.6	1.8

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 52%	Sound Lithotypes 48%
sandstone 18; siltstone 10; slate 8; felsic intrusive 6; shale 6; conglomerate 2; chert 2	sandstone 14; quartzite 10; greywacke 6; quartz 4; felsic intrusive 2; felsic extrusive 2; mafic extrusive 2; conglomerate 2; siltstone 2; argillite 2; metasedimentary 2

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
			Limited

LOCATION:	G9-10	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact (esker)	**COUNTY:**	Queens
EXPOSURE TYPE:	Pit	**PARISH:**	Wickham
STATUS:	Active-on-demand (lightly)	**UTM:**	326 578

SECTION DESCRIPTION & COMMENTS:

Upper Lift - North Face

0.5 m Soil: Slightly silty soil, developed on the underlying material.

7.0 m Gravel: Cross-bedded (southwestward-dipping) very fine to very coarse gravel; individual beds vary from openwork through to sandy (medium to very coarse sand); some beds are cobbly; Sample A was obtained from this unit.

1.7 m Slump Covered: Assumed to be material as above.

- West Face (10 m south of above section)

- Scraped Surface: Unknown thickness of material removed.

0.8 m Sandy Gravel: Trough cross-bedded fine to coarse gravel and medium to coarse sand; contains a one-clast thick cobble lag-gravel unit.

1.3 m Sand: Subhorizontally stratified medium to very coarse sand with minor very fine to fine gravel, grading downward into well-sorted medium sand with minor thin, silty very fine to fine sand layers.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% A pass.	86.2	74.4	65.4	46.2	29.7	17.7	9.3	4.6	2.3	1.4	0.9
B			100.0	98.9	92.6	78.4	54.7	27.0	10.0	4.6	1.9
C		86.7	79.8	59.3	44.4	38.5	-	23.7	14.0	4.4	1.3

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 38%	Sound Lithotypes 62%
slate 13; shale 9; weathered 4; siltstone 3; schist 3; mafic intrusive 2; sandstone 2; felsic intrusive 1; chert 1	quartzite 14; argillite 9; siltstone 7; limestone 7; sandstone 6; hornfels 5; mafic extrusive 4; felsic extrusive 3; felsic intrusive 2; mafic intrusive 2; greywacke 2; metasedimentary 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
20	10	6	600 000

LOCATION #: G9-10 (cont'd)

1.3 m Gravelly Sand: Subhorizontally stratified coarse to very coarse sand and very fine to medium gravel.

3.4 m Slump Covered: Assumed to be material as above.

Sample B was obtained from the two sand units.

Lower Lift

This lift exposes up to 9.1 m of sand and gravel. The material in this lift appears to be equally as variable as that in the upper lift. It consists of trough cross-beds, oriented parallel to the valley trend, that vary from gravelly sand through sandy gravel to coarse cobbly gravel.

Clasts in this deposit are subangular to rounded, with very light to light silt coatings, and some calcite coatings. Maximum clast size is 0.5 m, with clasts greater than 0.1 m in size estimated to comprise 1 to 2% of the material.

A 7.9 m section in this pit was also described and sampled by Brinsmead and Finamore (1977; their site G9-35). They observed 3.7 m of sandy gravel, the lower half cobbly and bouldery, above the talus slope. Sample C (their sample) was obtained from the upper half of the exposed section. Forty-six per cent of the clasts in their sample were unsound.

The pit area has also been sampled by DOT (1974). The results of their tests are as follows:

Mechanical Analysis (2 samples)
95 and 98% passing 50 mm
29 and 36% passing 4.75 mm
3.2 and 3.7% passing 75 um

Los Angeles Abrasion Loss: 29.9%

Recommended for borrow and subbase usage. Marginal for use as base-course aggregate.

An abandoned pit approximately 14 m deep lies to the south of G9-10 (UTM 326 576). Brinsmead and Finamore (1977; their site G9-34) described the material as a bouldery, cobbly sand and gravel, with little sand or fine gravel fractions. Clasts were described as angular to subangular; only 26% were unsound.

This deposit was interpreted as a meltwater-reworked kame terrace by Brinsmead and Finamore (1977). However, its hummocky topography is suggestive of a beaded esker. In addition, the valley does not appear to be wide enough to have contained an ice lobe large enough to form a kame terrace in this location. Consequently, the deposit is interpreted here as a southward-flowing esker system.

LOCATION:	G9-11	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash (delta)	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Kars
STATUS:	Abandoned	**UTM:**	326 555

SECTION DESCRIPTION & COMMENTS:

0.6 m Soil: Silty soil, developed in a very fine to fine sand.

1.6 m Gravelly Sand: Faintly stratified medium sand and very fine to medium gravel; contains a few thin fine to medium sand beds; Sample A was obtained from this unit.

6.2 m Slump Covered: Assumed to be material as above.

The above section is at the south end of the pit. The north end is locally gravellier, with some sandy gravel units. Maximum clast size in the pit area is 0.2 m, but clasts this large are rare.

This pit was also described and sampled by Brinsmead and Finamore (1977; their site G9-33). Their gravelly sand sample from the southern end of the pit (Sample B below) is coarser than Sample A. They also obtained a sand sample (Sample C below) from the northwest end of the pit. This material was predominantly fine to medium sand.

The pit area has also been tested by DOT (1973). The results of their tests, on seven samples, are as follows:

(CONTINUED)

MECHANICAL ANALYSIS:

sieve		25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass	A		100.0	97.1	94.3	90.9	86.0	74.2	33.2	9.0	4.4
	B	100.0	98.1	91.8	84.9	77.1	-	50.1	19.5	5.6	2.4
	C		100.0	99.7	98.5	95.6	-	82.9	60.8	21.3	5.3

LITHOLOGIC ANALYSIS: N.A.

Unsound Lithotypes	%	Sound Lithotypes	%

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
18	10	5	500 000

LOCATION #: G9-11 *(cont'd)*

Mechanical Analysis - sandy gravel (2 samples)
57 and 64% passing 4.75 mm
3.2 and 3.3% passing 75 um

- sand and gravelly sand (5 samples)
83 to 100% passing 4.75 mm (average 90%)
4.1 to 14.2% passing 75 um (average 8.7%)

Recommended for use as borrow, and as blending, filter, and winter sand.

This pit is developed near the frontal margin of the Beulah outwash delta. The material is, therefore, finer than that in the more proximal parts of the delta, to the east (see G9-12). Brinsmead and Finamore (1977; site G9-32) obtained a sample from the southern terminus of the deposit, and found it to be a silty very fine to medium sand (12.8% passing 75 um).

Bedrock is exposed just to the north of the deposit margin. Consequently, the workable thickness of the material may not be great in parts of the deposit area. Brinsmead and Finamore (1977) observed water at the base of the pit during their visit, indicating that the pit is near its maximum workable depth.

Reserves are calculated for that part of the delta lying east of the side road adjacent to the pit, and west of the small stream that flows through the deposit from Beulah.

LOCATION:	*G9-12*	NTS:	21 G/9
TYPE OF DEPOSIT:	Glaciofluvial outwash (delta)	COUNTY:	Kings
EXPOSURE TYPE:	Pit	PARISH:	Kars
STATUS:	Active-on-demand	UTM:	333 555

SECTION DESCRIPTION & COMMENTS:

0.5 m Soil: Slightly silty soil, developed on the underlying material.

1.4 m Gravel: Horizontally stratified, cobbly very fine to very coarse gravel, with a matrix of medium to coarse sand; contains minor beds of fine to medium sand, and medium to coarse sand.

6.2 m Sand and Gravel: Large-scale trough cross-beds, consisting of interbedded sandy gravel (dominant), openwork gravel, gravelly sand and sand; Sample A, a sandy gravel (very fine to very coarse gravel and medium to very coarse sand) is representative of most of the material in the unit; Sample B, a slightly silty sand, is representative of the finer material in the unit; it was obtained from a bed more than 2 m thick, consisting of very fine to medium sand with silty bands, and gravelly medium to coarse sand.

1.7 m Slump Covered: Assumed to be material as above.

Clasts in this deposit are subangular to rounded, with moderate to heavy silt coatings. Maximum clast size is 0.8 m. However, such large clasts are rare; clasts exceeding 0.1 m in size are estimated to comprise less than 1% of the material.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve		50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass	A	79.9	69.5	66.2	55.9	45.5	34.9	21.4	11.8	5.9	2.9	1.5
	B		100.0	98.9	97.6	95.4	91.1	83.8	68.8	42.6	20.5	8.9
	C		100.0	97.5	93.7	89.3	84.2	-	61.4	35.7	13.1	4.7

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 49%	Sound Lithotypes 51%
shale 11; schist 8; slate 7; siltstone 6; sandstone 4; metasedimentary 4; chert 2; weathered 2; felsic extrusive 1; mafic intrusive 1; mafic extrusive 1; conglomerate 1; metavolcanic 1	argillite 12; mafic extrusive 9; quartzite 5; quartz 5; felsic intrusive 3; felsic extrusive 3; sandstone 3; hornfels 3; siltstone 2; metasedimentary 2; gneiss 2; mafic intrusive 1; metavolcanic 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
38	15	7	1 million

LOCATION #: G9-12 (cont'd)

This pit was also described and sampled by Brinsmead and Finamore (1977; their site G9-41). The lower unit in the section that they observed consisted primarily of gravelly sand. Their test results are listed as Sample C.

The pit area has also been tested by DOT (1974). Their test results, for seven samples, are summarized below:

Mechanical Analysis
91 to 100% passing 50 mm (average 98%)
44 to 64% passing 4.75 mm (average 55%)
2.7 to 5.6% passing 75 um (average 3.8%)

Los Angeles Abrasion Loss: 27.1 to 31.0% (average 29.7%)

Recommended for use as borrow and subbase material.

This deposit is a kettled outwash delta, formed by meltwater flowing southwestward into estuarine waters in the Saint John River valley. The reserve estimate pertains to the eastern part of the deposit, lying to the east of the small stream that flows southwestward from Beulah.

LOCATION:	G9-13	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact (esker)	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Kars
STATUS:	Inactive	**UTM:**	318 537

SECTION DESCRIPTION & COMMENTS:

0.6 m Soil: Silty soil, developed in interbedded sand and sandy gravel.

0.2 m Sand: Clean fine to medium sand.

2.5 m Sandy Gravel: Subhorizontally stratified, fine to very coarse gravel and medium to very coarse sand; Sample A was obtained from this unit.

0.2 m Till: Dense, reddish brown, silty stony till.

6.8 m Sand and Gravelly Sand: Cross-bedded (southeastward paleoflow) sand and gravelly sand; individual beds generally consist of coarse to very coarse sand, or medium to coarse sand and very fine to medium gravel, with a few thin beds of very coarse sand and very fine gravel; some of the beds contain very thin silty stringers; Sample B was obtained from this unit.

10.7 m Slump Covered: Assumed to be material as above.

Clasts in this deposit are subangular to rounded, with moderate to heavy silt coatings. Maximum clast size is 0.6 m; however, clasts exceeding 0.1 m in size are very rare.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve	50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass A	85.4	60.1	54.0	39.5	31.3	25.2	18.9	11.8	5.0	2.3	1.4
% pass B		100.0	99.2	95.0	86.1	67.3	42.2	20.3	10.0	5.3	3.6

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 48%	Sound Lithotypes 52%
slate 11; schist 8; weathered 6; chert 5; shale 5; sandstone 4; felsic intrusive 3; siltstone 3; felsic extrusive 1; mafic intrusive 1; mafic extrusive 1	quartzite 11; sandstone 8; argillite 8; felsic intrusive 4; mafic intrusive 4; siltstone 4; felsic extrusive 3; quartz 3; metasedimentary 2; hornfels 2; mafic extrusive 1; limestone 1; gneiss 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
10	7	10	700 000

LOCATION #: G9-13 (cont'd)

The above section is through the crest of the deposit. The flank sections are slump covered in the most part, but do exhibit a draping of interbedded silty sand and fine to medium sand. This deposit is extremely thick; the landowner indicates that a well installed in the lowermost flank of the deposit penetrated 26 m of sand and gravel. The deposit comprises an esker segment in its northern half in which the pit is developed, that feeds into a small flat-topped kame delta to the south.

LOCATION:	G9-14	**NTS:**	21 G/9
TYPE OF DEPOSIT:	Ice-contact	**COUNTY:**	Kings
EXPOSURE TYPE:	Pit	**PARISH:**	Kingston
STATUS:	Active-on-demand	**UTM:**	302 426

SECTION DESCRIPTION & COMMENTS:

Upper Lift

0.5 m Soil: Slightly silty soil, developed on the underlying material.

1.5 m Sand and Gravel: Cross-bedded sand and gravel, consisting of interbeds of gravelly medium to coarse sand and sandy fine to very coarse gravel; clasts are angular to rounded, with light to moderate silt coatings; Sample A was obtained from this unit.

0.8 m Slump Covered: Assumed to be material as above.

Lower Lift

0.2 m Fill: Sand and gravel on the floor of the upper lift.

3.9 m Sand: 2.7 m of clean medium to coarse sand overlies 1.2 m of clean fine to medium sand; a few minor silty bands are present; subhorizontally bedded; Sample B was obtained from this unit.

0.5 m Slump Covered: Assumed to be material as above.

(CONTINUED)

MECHANICAL ANALYSIS:

sieve		50mm	25mm	19mm	9.5mm	4.75mm	2.36mm	1.18mm	600um	300um	150um	75um
% pass	A	86.7	76.9	71.0	61.5	53.6	43.4	29.2	13.2	4.1	1.9	1.4
	B					100.0	99.6	94.0	66.9	27.4	5.9	1.6
	C					100.0	99.9	-	86.7	42.2	9.5	2.3
	D		80.8	72.9	41.6	22.0	12.1	-	3.3	2.0	1.6	1.5

LITHOLOGIC ANALYSIS:

Unsound Lithotypes 68%	Sound Lithotypes 32%
weathered 15; sandstone 9; felsic extrusive 7; felsic intrusive 6; mafic extrusive 6; shale 6; mafic intrusive 4; schist 4; siltstone 3; slate 3; conglomerate 2; chert 2; metasedimentary 1	quartzite 9; argillite 5; mafic extrusive 3; hornfels 3; felsic intrusive 2; greywacke 2; limestone 2; metasedimentary 2; felsic extrusive 1; mafic intrusive 1; metavolcanic 1; quartz 1

ESTIMATION OF RESERVES:

Total Deposit Area (hectares)	Area Workable (hectares)	Average Thickness (metres)	Recoverable Reserves (m^3) Probable
			nearing depletion

LOCATION #: G9-14 (cont'd)

The above sections are at the southern end of the pit (at the southern margin of the map area). The part of the deposit to the north is essentially depleted. The pit has a cumulative maximum depth of about 22 m. A knob of striated bedrock is present at the base of the pit.

This pit has also been described and sampled by Brinsmead and Finamore (1977; their site G9-26). The section they observed comprised 1.8 m of sand and gravel over 3.4 m of sand over 10.7+ m of coarse cobbly gravel. Their analytical results for the sand and the cobbly gravel units are given above (Samples C and D, respectively). The lower unit is no longer exposed; it may have been depleted. It contained only 17% unsound lithotypes, and was thus much superior in quality to the upper sand and gravel unit.

The pit area has also been tested by DOT (1979). A summary of their test results, on ten samples, follows:

Pit Run Material

Mechanical Analysis - sandy gravel (3 samples)
48 to 68% passing 4.75 mm (average 59%)
1.2 to 1.9% passing 75 um (average 1.5%)

- sand and gravelly sand (6 samples)
76 to 99% passing 4.75 mm (average 87%)
1.0 to 6.0% passing 75 um (average 3.2%)

Los Angeles Abrasion Loss: 28.4 to 32.1% (average 30.3%)

Crushed Material

Mechanical Analysis (1 sample)
53% passing 4.75 mm; 2.8% passing 75 um

Absorption: stone 2.91%; sand 2.46%
Soundness Loss: stone 17.35%; sand 10.79%
Sand Equivalent: 73

The sandy gravel was recommended for use as borrow and subbase material. The sandy material was recommended for use as borrow, and as blending and winter sand.

This deposit appears to be a large esker segment or esker fan. The portion of the deposit in the Hampstead map area is nearing depletion. Reserves in the order of several hundred thousand m^3 remain in the Saint John map area, to the south.

G9-101 UTM 210 647

This pit is developed in a small ice-contact deposit, possibly a kame terrace, related to the deposit at G9-2. The pit is developed in two lifts, with a combined maximum section height of 18.2 m. The upper lift, 9.0 m deep and active-on-demand, exposes sand and gravel similar to that at G9-2: the material ranges from medium sand with silt bands through to cobbly gravel. The lower lift is abandoned and overgrown. However, a recent test pit in the base of this lift exposes relatively fine sandy gravel.

Remaining workable reserves in this deposit are estimated to be in the order of 100 000 m^3.

G9-102 UTM 279 545

This abandoned and overgrown pit is in a small outwash deposit. The road cut through this deposit is approximately 5 m high; the upper metre exposes sandy gravel.

Only a limited volume of workable material remains.

G9-103 UTM 283 538
285 533
290 531

These sites are building stone quarries developed in the Spoon Island granite. These quarries have been operated for more than 100 years (New Brunswick Department of Natural Resources 1978). Two colours of stone are available from this area; a pink variety, and a grey variety (Parks 1914). The northernmost of these quarries is still operated, on an intermittent basis, by Nelson Monuments Ltd. of Sussex.

G9-104 UTM 263 456

This pit is developed in a large, esker-fed, outwash delta along Flaglor Brook. The pit area has been tested by DOT (1978). The results of their tests are summarized below:

Pit Run Material (8 samples)

Mechanical Analysis
75 to 100% passing 50 mm (average 91%)
34 to 62% passing 4.75 mm (average 43%)
1.2 to 3.8% passing 75 um (average 2.0%)

Los Angeles Abrasion Loss: 25.5 to 27.4% (average 26.3%)

Crushed Material (1 sample)

Mechanical Analysis
48% passing 4.75 mm; 2.1% passing 75 um

Absorption: stone 2.22%; sand 1.95%
Soundness Loss: stone 7.44%; sand 3.14%
Sand Equivalent: 85

The material was approved for use as borrow, subbase, base-course, and asphaltic concrete aggregate, and as coarse-surface treatment chips.

The high-level terrace in which the pit is developed (to the east of the brook) is estimated to contain workable reserves in the order of 2 million m^3. The similar terrace to the west of the brook is estimated to contain an additional 1.5 million m^3. The dimensions of these deposits are not accurately known; consequently, reserve volumes could be less than estimated, or significantly greater. Detailed test pitting would be required to accurately assess the reserve potential of these deposits.

G9-105 UTM 328 581

This pit exposes up to 12 m of sand and gravel, similar to that at site G9-10 but coarser, with significantly more oversize material. Maximum clast size is 1.3 m. To the east of this pit, up to 0.6 m of clay overlies the sand and gravel, indicating that the deposit was at least partially submerged by marine(?) waters subsequent to formation.

G9-106 UTM 323 555

This inactive pit is developed in the western end of the Beulah outwash delta (see G9-11, 12). However, the configuration of this half of the deposit, and the contrast between the material exposed in this pit and that exposed at site G9-11, suggest that this area may comprise an ice-contact deposit, related to that to the north (G9-10), that was subsequently overlain, in part, by deltaic deposits.

The maximum exposure in the pit is approximately 12 m, comprising the following sequence:

1 m clay

1 m fine sand with silty bands

10 m sandy gravel, becoming cobbly with depth

The clay and sand units are tentatively interpreted as distal delta foreslope deposits, and the underlying sandy gravel as ice-contact material.

This pit area has been tested by DOT (1973). Their test results were as follows:

Mechanical Analysis (5 samples)
81 to 100% passing 50 mm (average 90%)
38 to 69% passing 4.75 mm (average 49%)
1.4 to 2.9% passing 75 um (average 1.9%)

Los Angeles Abrasion Loss: 25.0 to 29.7% (average 27.4%)

Recommended for use as borrow, subbase, base-course, and coarse-cover aggregate, with the exception of the one fine-grained sample, that was recommended for use as borrow and winter sand.

Workable reserves in the part of the deposit to the west of the road beside G9-11 are estimated to be in the order of 500 000 m^3.

G9-107 UTM 298 547

This road cut exposure was described by Brinsmead and Finamore (1977; their location G9-36). Approximately 2 m of gravelly medium to coarse sand, of presumed marine shoreline origin, is exposed. Brinsmead and Finamore (1977) report 93.7% passing 4.75 mm, and 3.9% passing 75um. They note that the material appears to become siltier with depth. Workable reserves are limited.

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